School of Data and Computer Science, Sun Yat-sen University

P02 CSP and KRR

Zhaoshuai Liu, Chenyang Li

October 14, 2018

Contents

1 Futoshiki (GAC, C++/Python)

1.1 Description

Futoshiki is a board-based puzzle game, also known under the name Unequal. It is playable on a square board having a given fixed size (4×4 for example), please see Figure 1.

The purpose of the game is to discover the digits hidden inside the board's cells; each cell is filled with a digit between 1 and the board's size. On each row and column each digit appears exactly once; therefore, when revealed, the digits of the board form a so-called Latin square.

At the beginning of the game some digits might be revealed. The board might also contain some inequalities between the board cells; these inequalities must be respected and can be used as clues in order to discover the remaining hidden digits.

Each puzzle is guaranteed to have a solution and only one.

You can play this game online: `http://www.futoshiki.org/`.

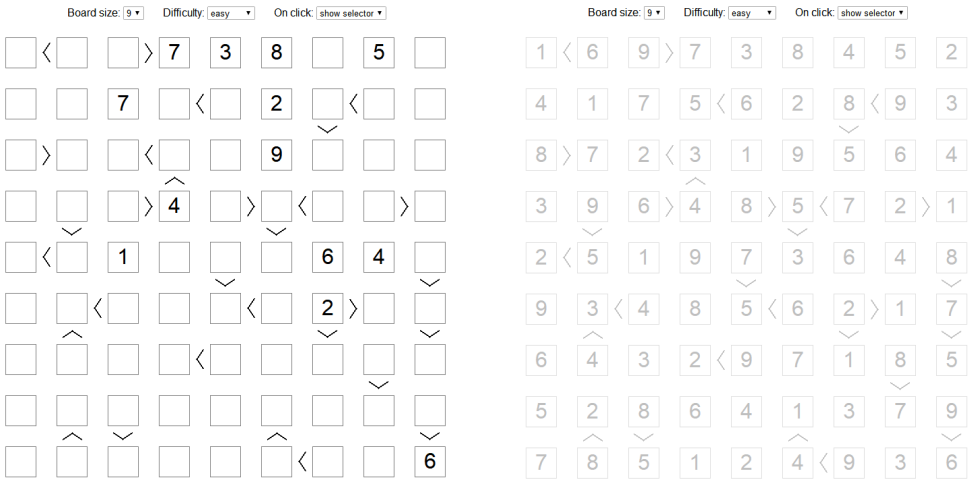

Figure 1: Futoshiki Puzzles

1.2 Tasks

1. You should use **GAC** algorithm to implement a Futoshiki solver by **C++** or **Python**.
2. If necessary, you could add some heuristic strategies to speed up your algorithm.
3. You should run the following 5 test cases to verify your solver's **correctness** and **efficiency** in Figure 2, 3, 4, 5, and 6, and I will grade your codes in **GAC implementation**, **correctness of 5 cases** and **algorithm efficiency**.
4. Don't forget you have implemented this game by FC algorithm in E04.

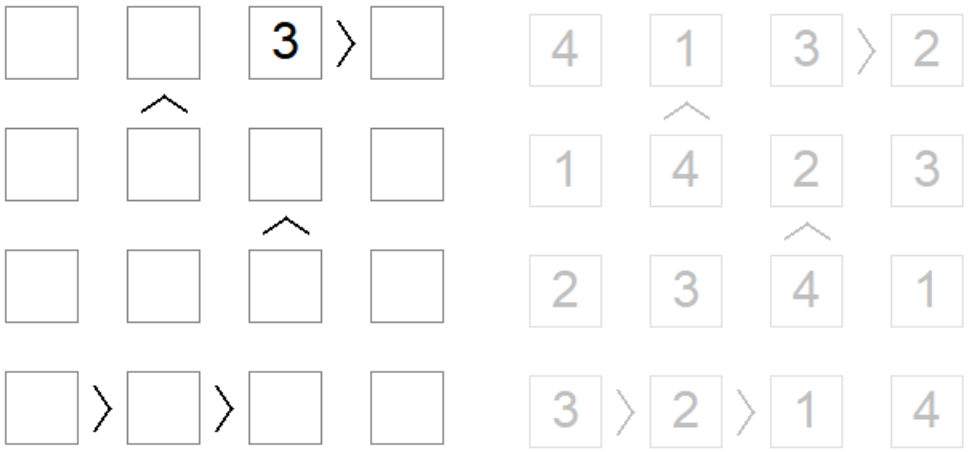

Figure 2: Futoshiki Test Case 1

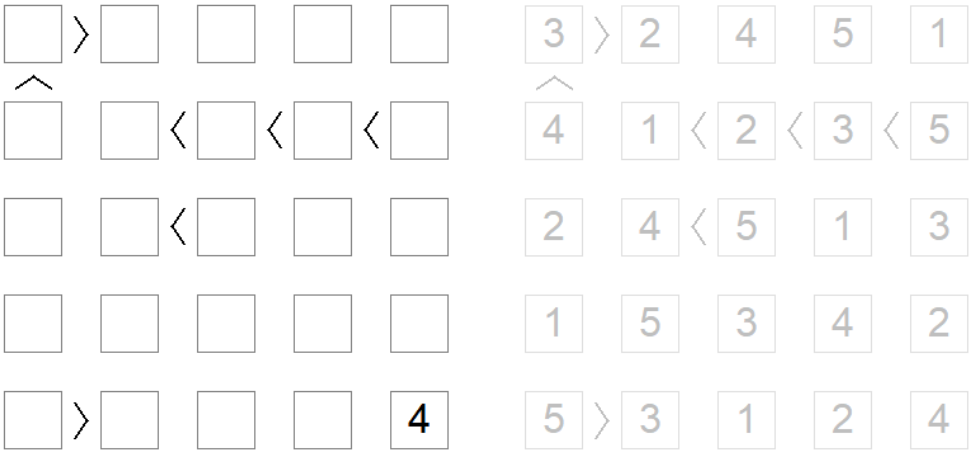

Figure 3: Futoshiki Test Case 2

Figure 4: Futoshiki Test Case 3

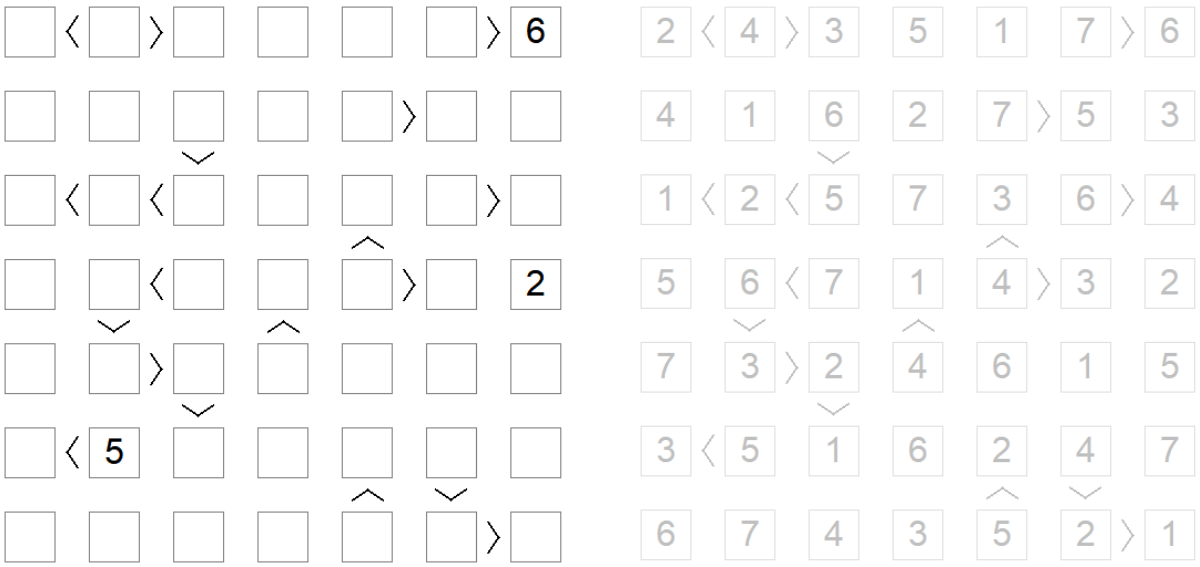

Figure 5: Futoshiki Test Case 4

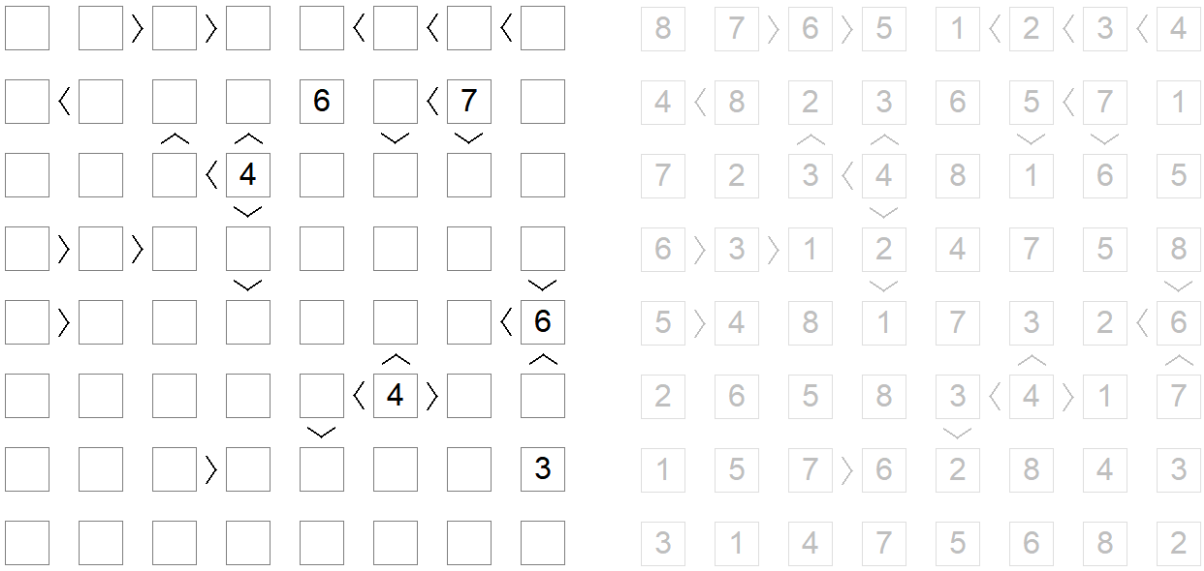

Figure 6: Futoshiki Test Case 5

2 Blocks World (Planner, Prolog)

2.1 Description

Planning in the blocks world is a traditional planning exercise, and you can recall what we have introduced in class in Figure 7:

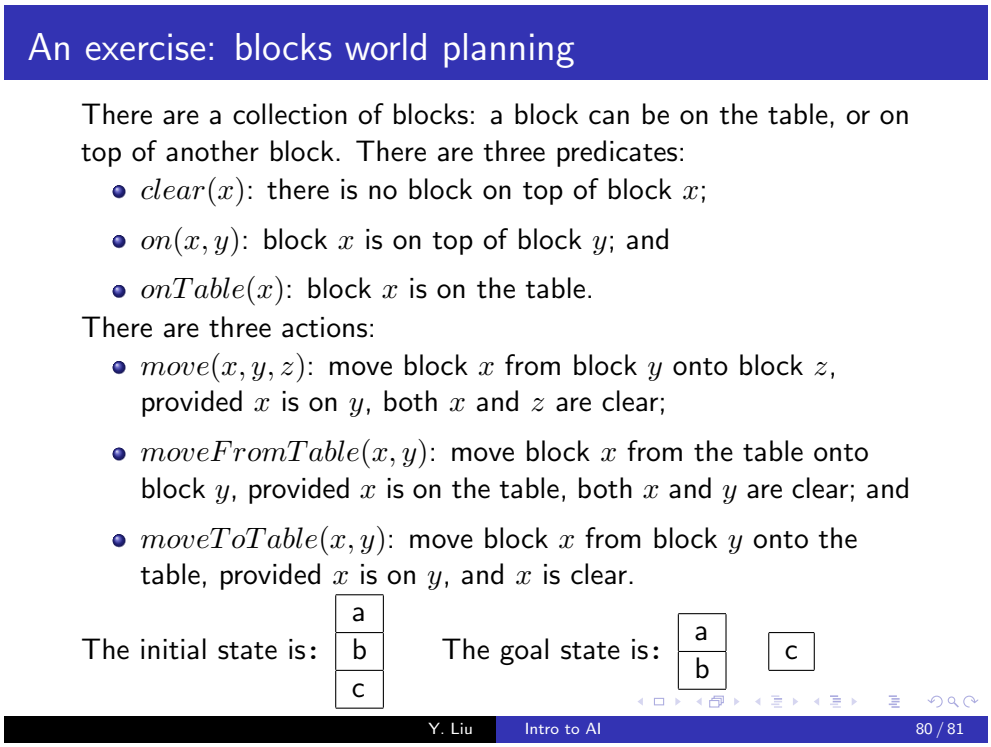

Figure 7: Blocks World

Here are several hints for you to develop a blocks world planner by using Prolog:

- You can represent the states with `on(Block,Object)` and `clear(Object)`. You'd better take into account the location of the blocks, so `Objection` can be a block or a place.
- The only kind of action can be `move(Block,From,To)`.
- Each available action is defined in terms of its precondition and its effects. Preconditions can be defined by the procedure `can(Action,Cond)`. The effects of an action can be defined by two procedures:`adds(Action,AddRels)` and `deletes(Action,DelRels)`.
- The planner aims at finding a plan, that is, a sequence of actions, which achieves the goal. You can adopt the principle of planning by means-ends analysis illustrated in Figure 8:
- In order to delete unnecessary steps, you can consider avoiding those actions that destroy goals.

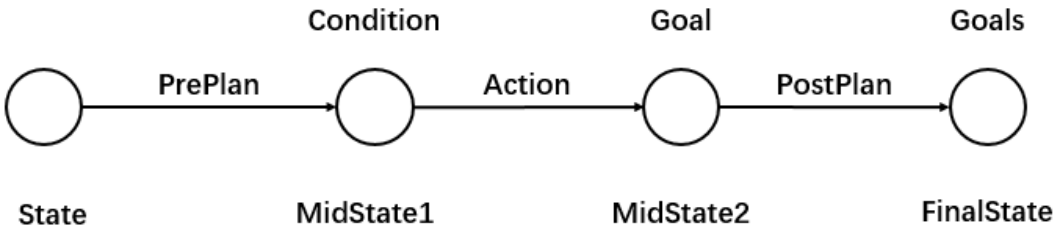

Figure 8: The Principle of Means-Ends Planning

2.2 Tasks

- Please develop a planner to solve the blocks world problem by using Prolog.
- There are 5 cases (Figure 9, Figure 10, Figure 11, Figure 12 and Figure 13) for you to test the performance of your planner. I will grade your planner in **correctness of cases**, **the number of steps**, and **time cost**.
- Adopting breadth-first and best-first heuristic can accelerate the planner, however, you can optimize your planner by using better heuristic functions or other means.

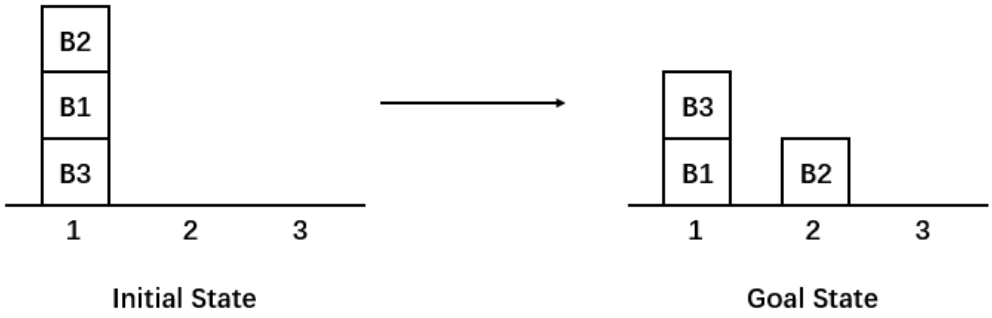

Figure 9: Blocks World Case 1

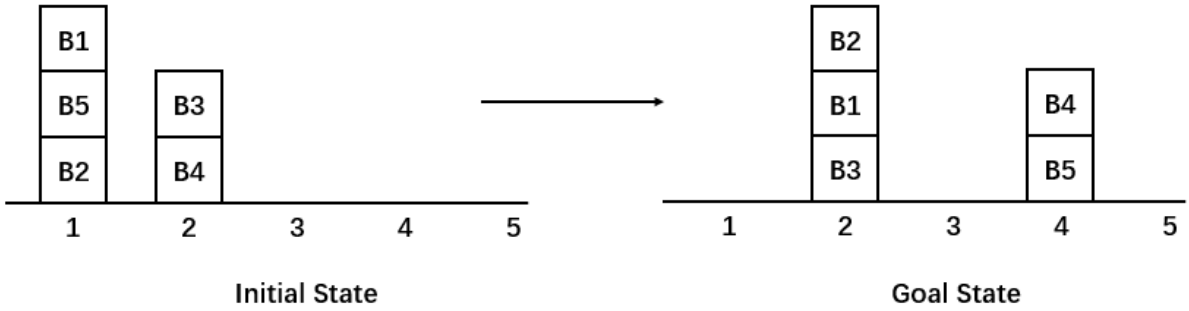

Figure 10: Blocks World Case 2

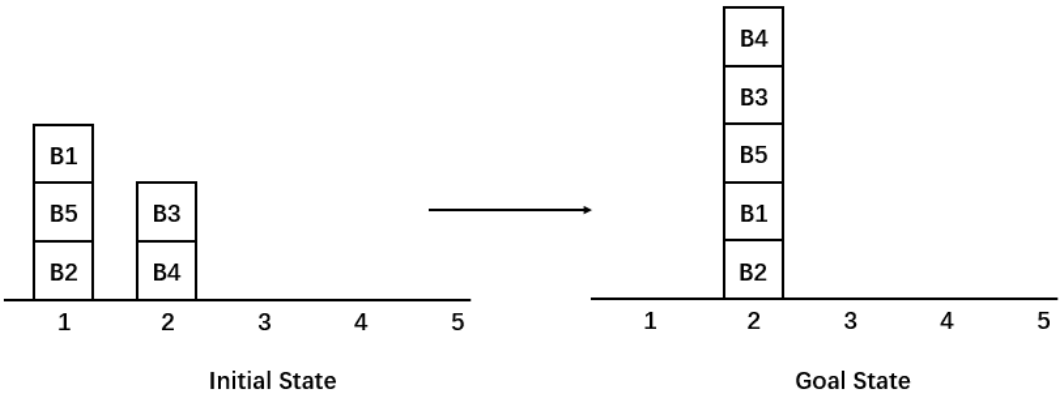

Figure 11: Blocks World Case 3

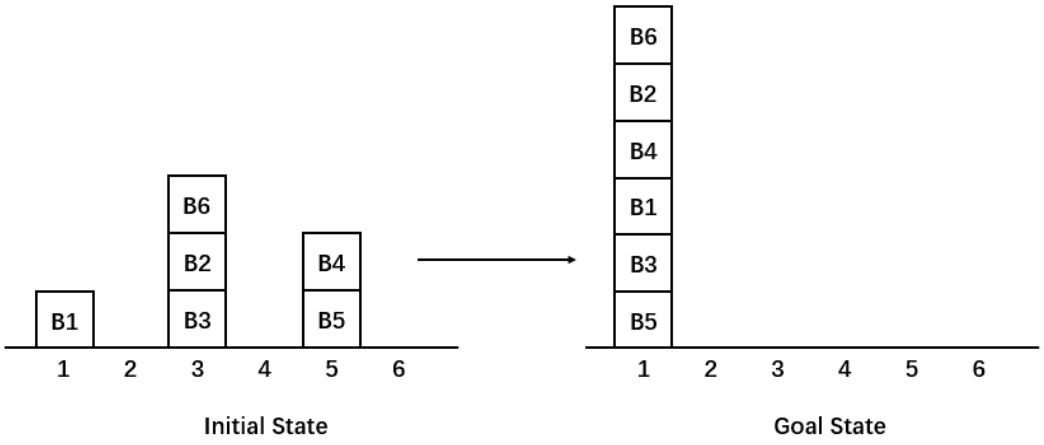

Figure 12: Blocks World Case 4

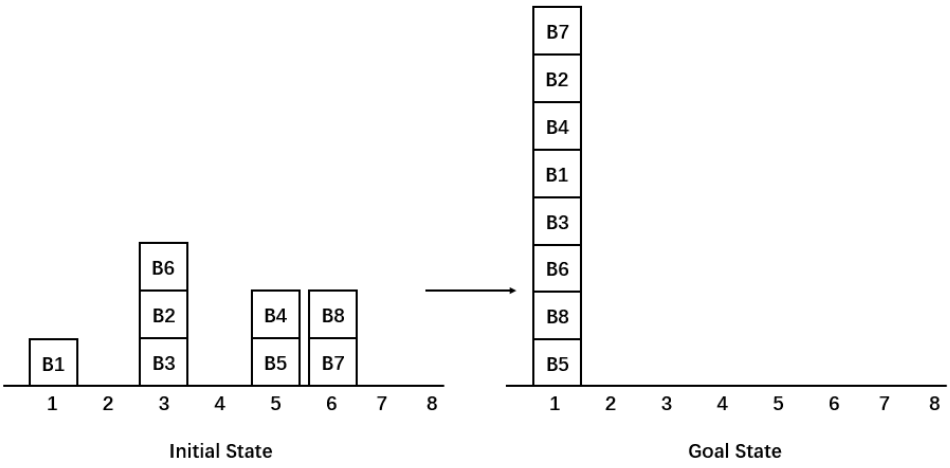

Figure 13: Blocks World Case 5

3 Notes

- Please send **P02_Number1_Number2.zip** to the mailbox (**ai_2017@foxmail.com**) before the deadline (**2018/10/28 23:59**). The `zip` file should contain several files: **futoshiki_gac.cpp** or **futoshiki_gac.py**, **blocksworld.pl**, **results pictures** and **other necessary files**, such as data files and README.

- Last but not least, you are not alone! If you find yourself stuck on something, contact the TA (QQ: 24747380) for help.